



# Robotic-assisted free-handed, full-thickness gastric GIST resection with primary repair in unfavorable locations

Mattie Arseneaux<sup>1</sup> · Donald Yarbrough<sup>1</sup> · Toshio Nagamoto<sup>1</sup>

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## Abstract

Complete R0 resection of gastrointestinal stromal tumors (GIST) of the stomach without signs of metastasis is highly reported, and the techniques for tumor resection have been evolving. Previously, laparoscopy was suggested to be safe only for GIST tumors < 2 cm. More recent reports demonstrate safety of resecting gastric GIST tumors laparoscopically > 5 cm even in unfavorable locations defined as GE junction, lesser curvature of gastric body, posterior wall of gastric body, and antrum. The most common resection method for gastric GIST resection is wedge resection, regardless if the surgery is completed open, laparoscopic, or robotically. Free-handed, full-thickness resection with primary repair is not commonly reported. This paper includes three cases of gastric GIST tumors in unfavorable locations resected robotically, free-handed, full-thickness resection with primary repair.

**Keywords** GIST · Unfavorable location · Robotic · Primary repair

## Introduction

Gastrointestinal stromal tumors (GIST) are the most common primary mesenchymal tumor of the gastrointestinal tract. The most common location of GIST is the stomach, followed by the small bowel, and colorectal [1]. One common treatment of primary GIST tumor without signs of metastasis is tumor resection. The goal of resection is R0 margins without rupturing the pseudocapsule [2]. The surgical approach has evolved from open to laparoscopic resection limited to tumors < 2 cm to more current reports suggesting the safety of using laparoscopy for large GIST tumors measuring > 5 cm [3–5]. Reported concerns regarding laparoscopic resection of gastric GISTs include tumors in unfavorable locations, such as the GE junction, lesser curvature of gastric body, posterior wall of gastric body, and antrum [6, 7]. Recent reports have demonstrated the safety of laparoscopic GIST resection in unfavorable locations with stapled wedge resection [6, 7]; however, not many studies report the use of robotic-assisted laparoscopic resection of GIST. This report includes three cases using robot-

assisted resection of gastric GIST tumors in unfavorable locations with free-handed, full-thickness excision and primary repair with single or double full-layer thickness suturing.

## Patient presentations

The first patient was a 69-year-old female, who was found to have a gastric tumor on EGD performed for dysphagia. The EGD was remarkable for esophagitis, a hiatal hernia, and a > 7 cm submucosal mass on the posterior lesser curvature of the stomach near the antrum. Endoscopic ultrasound (EUS) and biopsy were consistent with GIST tumor, and CT scan ruled out metastatic disease. The patient was asymptomatic from the tumor. The second patient was a 59-year-old male whose mass was found incidentally on CT scan of the abdomen at the superior medial wall of the stomach near the GE junction measuring about 2.8 cm × 1.0 cm. The mass was worked up with EGD, EUS, and biopsy. The EUS demonstrated the features of GIST, but the biopsy was non-diagnostic. The patient was asymptomatic from the tumor. The third patient was a 78-year-old male, who was found to have a gastric tumor 4.5 cm and located on the posterior portion of the greater curvature and gastric diverticulum found incidentally on a CT scan done for urinary retention. The mass was further worked up with EGD and EUS and the

✉ Mattie Arseneaux  
marseneaux@atsu.edu

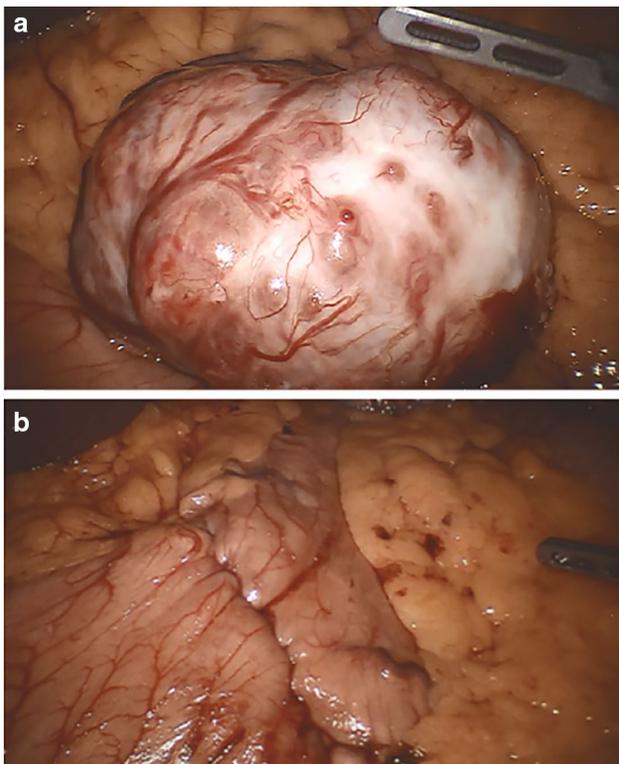
<sup>1</sup> Department of Surgery, Western University College of Osteopathic Medicine Pacific-Northwest, Lebanon, USA

findings were consistent with GIST tumor. The patient was asymptomatic from the tumor.

## Operative technique

All cases utilized robot-assistance free-handed (non-stapled) partial gastrectomy with primary hand sewn closure repair of the stomach. The patient was placed in the supine position and five laparoscopic ports were placed across the upper abdomen. The daVinci Robotic System (Sunnyvale, CA) was docked in the typical fashion. An internal bulldog clamp was placed on the pars flaccida to elevate the liver and allow for a better visualization of the stomach.

In case one, the GIST was > 7 cm located on the posterior stomach near the angularis on the lesser curvature, as shown in Fig. 1a. Due to the large size and location of the tumor, a stapled wedge resection was thought to likely lead to unacceptable narrowing of the stomach. Instead, a free-hand gastric resection using ultrasonic dissector was used to remove the mass. Simultaneous EGD was utilized to guide the resection margins. The defect was large, oriented obliquely, and within less than 1 cm of the greater curvature. The defect was repaired transversely using running 2–0 Vicryl with single full-layer thickness imbricating suture line with defect

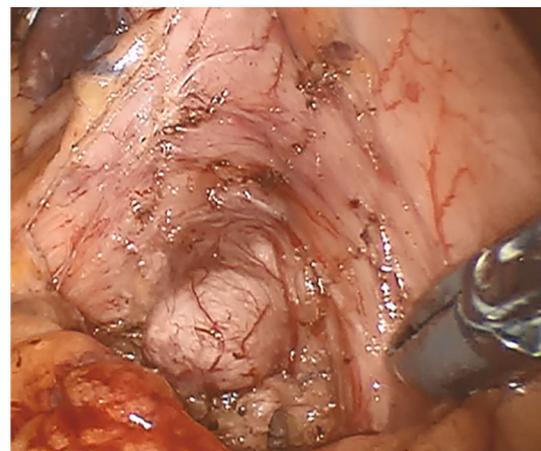


**Fig. 1** a 7.5 cm gastric GIST located on posterior lesser curvature. b Primary robotic-assisted repair in a 69-year-old female

closed, as shown in Fig. 1b. EGD was utilized to confirm patency and to check for any leaks and there were none. Pathology confirmed a 7.5 cm × 5.0 cm × 1.5 cm GIST with negative margins and non-ruptured pseudocapsule. This procedure was combined with hiatal hernia repair and Nissen fundoplication for medically refractory GERD. The patient did well without any complications and was discharged home on post-operative day 1 on a full liquid diet. Patient continues to do well 5-month post-operatively.

The second case involved a 2-cm mass located along the posterior portion of the lesser curvature near the GE junction, and the operative approach was the same. EGD was used to locate the mass and guide resection. Once localized at the posterior portion of the lesser curvature near GE junction as shown in Fig. 2, the lesser curve was mobilized. The mass was resected using free-hand resection with ultrasonic dissector and 1-cm margins were obtained. The defect was large and located near the GE junction along the lesser curvature. Primary repair was performed using 2–0 running Vicryl single-layer full-thickness imbricating suture line. EGD was done at end of procedure to confirm patency and check for a leak, and no leak was detected. Pathology confirmed a 2.0-cm × 1.7-cm × 1.2-cm GIST with negative margins and non-ruptured pseudocapsule. The patient did well post-operatively with no stenosis or obstruction. His hospital course was complicated by acute blood loss anemia while bridging him back to Coumadin post-operatively for his mechanical heart valves. He required a few units of packed red blood cells, but no surgical intervention was necessary. His hemoglobin stabilized, and he was safely bridged back to Coumadin. Patient continues to do well 4-month post-operatively.

The third case involved a gastric mass and diverticulum that, according to EGD, were 5 cm from the GE junction along the lesser curvature. However, upon entering the



**Fig. 2** 2-cm gastric GIST located posteriorly near the GE junction in a 59-year-old male

abdomen, it was apparent that this was not the location of the tumor or diverticulum. After full visualization of lesser curvature and reduction of hiatal hernia, the stomach was further mobilized by dividing the short gastric vessels with a vessel sealer. Full mobilization of the fundus allowed for the identification of the diverticulum and mass along the posterior portion of the fundus. 2–0 Vicryl stitch was placed proximally above the GIST as a marker of the tumor and visual aid to avoid GE junction. The gastric diverticulum was noted to be at the inferior portion of the GIST, so dissection of the gastric diverticulum and mass was carried out with free-hand technique using ultrasonic dissector. 2–0 Vicryl was used in running fashion with full-thickness closure. 3–0-V lock suture was used in seromuscular layer for a double-layer closure. The hiatal hernia defect was repaired at the end of the case. Pathology confirmed 4.5-cm GIST with negative margins and non-ruptured pseudocapsule. Patient did well post-operatively without complications and discharged home on post-operative day 2 on full liquid diet. Patient continues to do well 1-month post-operatively.

## Discussion

We demonstrate the feasibility of free-handed primary robotic resection of gastric GIST tumors in difficult locations, one of which was >7 cm along the posterior lesser curvature and the other at the posterior GE junction. All operations resulted in R0 resections and without severe complications or stenosis.

Gastric GIST resection options are continuing to expand including open, laparoscopic, robotic, and endoscopic techniques [7]. Many studies have shown the safety of laparoscopic technique to resect large gastric GISTs [3–5]. Gastric GISTs in unfavorable locations such as GE junction, lesser curvature of gastric body, posterior wall of gastric body, and antrum pose an additional technical challenge, but have been successfully resected laparoscopically [6, 7]. Liao et al. [7] compared the laparoscopic management of gastric GIST in favorable versus unfavorable locations [7]. This study showed no significant difference in operative times, conversion from laparoscopic to open technique, estimated blood loss, tumor rupture rate, and post-operative complications [7]. The study did find a significant difference in use of endoscopy to find the tumor with endoscopy used 20.72% of the time in unfavorable locations versus 5.63% of the time in favorable locations [7], and we found endoscopy useful to guide resection.

The most documented technique in gastric GIST resection is stapled wedge resection, regardless if the operation was performed open, laparoscopically, or robotically [7]. However, tumors located near the cardia or pylorus of the stomach pose a threat of stenosis if removed with wedge

resection [7]. To avoid stenosis, gastric GIST in unfavorable locations may best be resected using the following techniques: laparoscopic seromuscular dissection, transgastric resection, or laparoscopic intragastric submucosal dissection [7]. Transgastric resection with primary repair is not commonly reported for gastric GIST resections [7].

Part of the challenge with minimally invasive resection of gastric GISTs in unfavorable locations is manipulating the stomach in a manner that provides adequate exposure for resection and repair. Robotic surgery provides advantages over laparoscopy with a magnified three-dimensional view and instruments with more articulation, which may facilitate dissection [8]. To our knowledge, there has only been one study comparing robotic and laparoscopic GIST resection, which included a size-matched and location-matched cohort of 12 robotic gastric GIST resections versus 24 laparoscopic gastric GIST resections [3]. There was no significant difference between the estimated blood loss, time to flatus, and hospital stay; however, robotic cases were longer with 162.5-min average time versus 130-min average time for laparoscopic cases [3]. There was also a significant difference in the cost between the two, with a 21.6% increase in robotic cases compared to laparoscopic cases [3].

## Compliance with ethical standards

**Conflict of interest** Dr. Arseneaux and Dr. Nagamoto declare that they have no conflict of interest. Dr. Yarbrough is a proctor surgeon for Intuitive Surgical and receives a stipend for clinical proctoring and lectures.

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